

Entomological warfare

Entomological warfare (EW) is a type of [biological warfare](#) that uses [insects](#) to interrupt supply lines by damaging crops, or to directly harm enemy combatants and civilian populations. There have been several programs which have attempted to institute this methodology; however, there has been limited application of entomological warfare against military or civilian targets, [Japan](#) being the only state known to have verifiably implemented the method against another state, namely the [Chinese during World War II](#). However, EW was used more widely in antiquity, in order to repel sieges or cause economic harm to states. Research into EW was conducted during both World War II and the [Cold War](#) by numerous states such as the [Soviet Union](#), [United States](#), [Germany](#) and [Canada](#). There have also been suggestions that it could be implemented by non-state actors in a form of [bioterrorism](#). Under the [Biological and Toxic Weapons Convention](#) of 1972, use of insects to administer agents or toxins for hostile purposes is deemed to be against international law.

Description

EW is a specific type of biological warfare (BW)^[1] that uses [insects](#) in a direct attack or as vectors to deliver a [biological agent](#), such as [plague](#) or [cholera](#). Essentially, EW exists in three varieties.^[2] One type of EW involves infecting insects with a [pathogen](#) and then dispersing the insects over target areas.^[3] The insects then act as a [vector](#), infecting any person or animal they might bite. Another type of EW is a direct insect attack against crops; the insect may not be infected with any pathogen but instead represents a threat to agriculture.^[3] The final method of entomological warfare is to use uninfected insects, such as bees, to directly attack the enemy.^[2]

Early history

Entomological warfare is not a new concept; historians and writers have studied EW in connection to multiple historic events. A 14th-century plague epidemic in Asia Minor that eventually became known as the [Black Death](#) (carried by [fleas](#)) is one such event that has drawn attention from historians as a possible early incident of entomological warfare.^[4] That plague's spread over Europe may have been the result of [a biological attack on the Crimean city of Kaffa](#) by the [Golden Horde](#).^[4]

According to [Jeffrey Lockwood](#), author of [Six-Legged Soldiers](#) (a book about EW), the earliest incident of entomological warfare was probably the use of [bees](#) by early humans.^[5] The bees or their nests were thrown into caves to force the enemy out and into the open.^[5] Lockwood theorizes

that the [Ark of the Covenant](#) may have been deadly when opened because it contained deadly fleas.^{[5][6]}

During the [American Civil War](#) the Confederacy accused the Union of purposely introducing the [harlequin bug](#) in the South.^[1] These accusations were never proven, and modern research has shown that it is more likely that the insect arrived by other means.^[1] The world did not experience large-scale entomological warfare until World War II; Japanese attacks in China were the only verified instance of BW or EW during the war.^[1] During, and following, the war other nations began their own EW programs.

World War II



The Colorado potato beetle was considered as an EW weapon by nations on both sides of WWII

France

[France](#) is known to have pursued entomological warfare programs during World War II.^[7] Like Germany, the nation suggested that the [Colorado potato beetle](#), aimed at the enemy's food sources, would be an asset during the war.^[7] As early as 1939 biological warfare experts in France suggested that the beetle be used against German crops.^[8]

Germany

Germany is known to have pursued entomological warfare programs during World War II.^[7] The nation pursued the mass-production, and dispersion, of the Colorado potato beetle (*Lepinotarsa decemlineata*), aimed at the enemy's food sources.^[7] The beetle was first found in Germany in 1914, as an invasive species from North America.^[9] There are no records that indicate the beetle was ever

employed as a weapon by Germany, or any other nation during the war.^[9] Regardless, the Germans had developed plans to drop the beetles on English crops.^[10]

Germany carried out testing of its Colorado potato beetle weaponization program south of [Frankfurt](#), where they released 54,000 of the beetles.^[9] In 1944, an infestation of Colorado potato beetles was reported in Germany.^[9] The source of the infestation is unknown, but speculation has offered three alternative theories as to the origin of the infestation. One option is Allied action, an entomological attack, another is that it was the result of the German testing, and another more likely explanation is that it was merely a natural occurrence.^[9]

Canada

Among the Allied Powers, [Canada](#) led the pioneering effort in vector-borne warfare.^[4] After Japan became intent on developing the plague flea as a weapon, Canada and the United States followed suit.^[4] Cooperating closely with the United States, Dr. G.B. Reed, chief of [Kingston's Queen's University's](#) Defense Research Laboratory, focused his research efforts on mosquito vectors, biting flies, and plague-infected fleas during World War II.^[11] Much of this research was shared with or conducted in concert with the United States.^[11]

Canada's entire bio-weapons program was ahead of the British and the Americans during the war.^[4] The Canadians tended to work in areas their allies ignored; entomological warfare was one of these areas.^[4] As the U.S. and British programs evolved, the Canadians worked closely with both nations. The Canadian BW work would continue well after the war,^[12] including entomological research.^[11]

Japan



Philadelphia Department of Health poster warning the public of housefly hazards (c. 1942)

Japan used entomological warfare on a large scale during World War II in [China](#).^[13] [Unit 731](#), Japan's biological warfare unit, led by Lt. General [Shirō Ishii](#), used plague-infected [fleas](#) and flies covered with cholera to infect the population in China.^[13] Japanese Yagi bombs developed at Pingfan consisted of two compartments, one with houseflies and another with a bacterial slurry that coated the houseflies prior to release. The Japanese military dispersed them from low-flying airplanes; spraying the fleas from them and dropping the Yagi bombs filled with a mixture of insects and disease.^[7] Localized and deadly [epidemics](#) resulted and nearly 500,000 Chinese died of disease.^{[13][14]} An international symposium of historians declared in 2002 that Japanese entomological warfare in China was responsible for the deaths of 440,000.^[7] It should also be noted that the U.S. granted Japanese 731 officials immunity from prosecution in exchange for their research, and members of the former 731 Unit went on to have successful careers in business, academia, and medicine.^[15]

United Kingdom

A British scientist, [J.B.S. Haldane](#), suggested that Britain and Germany were both vulnerable to entomological attack via the Colorado potato beetle.^[8] In 1942 the United States shipped 15,000 Colorado potato beetles to Britain for study as a weapon.^[9]

Cold War

Soviet Union

The Soviet Union researched, developed and tested an entomological warfare program as a major part of an anti-crop and anti-animal BW program. The Soviets developed techniques for using insects to transmit animal pathogens, such as: [foot and mouth disease](#)—which they used [ticks](#) to transmit; [avian ticks](#) to transmit *Chlamydophila psittaci* to chickens; and claimed to have developed an automated mass insect breeding facility, capable of outputting millions of parasitic insects per day.^[16]

United States

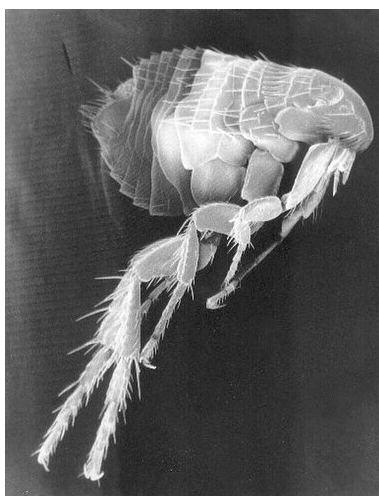


The U.S. dropped over 300,000 uninfected [mosquitoes](#) on its own population.

The United States seriously researched the potential of entomological warfare during the [Cold War](#). Labs at [Fort Detrick](#) were set up to produce 100 million yellow fever-infected mosquitoes per month deliverable by bombs or missiles.^[7] The facility could also breed 50 million fleas per week and later experimented with other diseases such as [anthrax](#), [cholera](#), [dengue](#), [dysentery](#), [malaria](#), [relapsing fever](#), and [tularemia](#).^[1] A U.S. Army report^[13] titled "Entomological Warfare Target Analysis" listed vulnerable sites within the Soviet Union that the U.S. could attack using entomological vectors.^[7] The military also tested the mosquito biting capacity by dropping uninfected mosquitoes over U.S. cities.^[7]

[North Korean](#) and Chinese officials leveled accusations that during the [Korean War](#) the United States engaged in biological warfare, including EW, in North Korea. The claim is dated to the period of the war, and has been thoroughly denied by the U.S.^[17] In 1998, Stephen Endicott and [Edward Hagerman](#) claimed that the accusations were true in their book, *The United States and Biological Warfare: Secrets from the Early Cold War and Korea*.^[11] The book received mixed reviews, some

called it "bad history"^[18] and "appalling",^[17] while others praised the case the authors made.^[18] Other historians have revived the claim in recent decades as well.^[19] The same year Endicott and Hagerman's book was published Kathryn Weathersby and Milton Leitenberg of the Cold War International History Project at the [Woodrow Wilson Center](#) in Washington released a cache of Soviet and Chinese documents which revealed the North Korean claim was an elaborate disinformation campaign.^[19]



A [rat flea](#), the species used in U.S. EW testing during the 1950s

During the 1950s the United States conducted a series of field tests using entomological weapons. [Operation Big Itch](#), in 1954, was designed to test munitions loaded with uninfected fleas (*Xenopsylla cheopis*).^[8] Big Itch went awry when some of the fleas escaped into the plane and bit all three members of the air crew.^[8] In May 1955 over 300,000 uninfected mosquitoes (*Aedes aegypti*) were dropped over parts of the U.S. state of Georgia to determine if the air-dropped mosquitoes could survive to take meals from humans.^[20] The mosquito tests were known as [Operation Big Buzz](#).^[14] [Operation Magic Sword](#) was a 1965 U.S. military operation designed to test the effectiveness of the sea-borne release of insect vectors for biological agents. The U.S. engaged in at least two other EW testing programs, [Operation Drop Kick](#) and [Operation May Day](#).^[20] A 1981 Army report outlined these tests as well as multiple cost-associated issues that occurred with EW.^[20] The report is partially declassified—some information is blacked out, including everything concerning "Drop Kick"^[20]—and included "cost per death" calculations.^[3] The cost per death, according to the report, for a vector-borne biological agent achieving a 50% mortality rate in an attack on a city was \$0.29 in 1976 dollars (approximately \$1.01 today).^[20] Such an attack was estimated to result in 625,000 deaths.^[20]

At [Kadena Air Force Base](#), an Entomology Branch of the [U.S. Army Preventive Medicine Activity](#), U.S. Army Medical Center was used to grow "medically important" arthropods, including many strains of mosquitoes in a study of disease vector efficiency.^[21] The program reportedly supported a research

program studying taxonomic and ecological data surveys for the [Smithsonian Institution](#).^[21] The Smithsonian Institution and [The National Academy of Sciences](#) and [National Research Council](#) administered special research projects in the Pacific.^[22] The Far East Section of the Office of the Foreign Secretary (the NAS Foreign Secretary, not the UK office) administered two such projects which focused "on the flora of Okinawa" and "trapping of airborne insects and arthropods for the study of the natural dispersal of insects and arthropods over the ocean."^[22]:59 The motivation for civilian research programs of this nature was questioned when it was learned that such international research was in fact funded by and provided to the U.S. Army as part of the U.S. military's biological warfare research.^{[23][24]}

The United States has also applied entomological warfare research and tactics in non-combat situations. In 1990 the U.S. funded a \$6.5 million program designed to research, breed and drop [caterpillars](#).^[25] The caterpillars were to be dropped in [Peru](#) on [coca](#) fields as part of the American war on drugs.^[25]

In 1996 Russia filed charges on behalf of [Cuba](#). The Cubans had been accusing the United States of using insects to spread [dengue fever](#) and other crop pests during the Cold War. A committee was formed to investigate the accusation but could neither confirm nor deny the charges.^[26]

In 2002 U.S. entomological anti-drug efforts at [Fort Detrick](#) were focused on finding an insect vector for a [virus](#) that affects the [opium poppy](#).^[3]

Bioterrorism

[Clemson University](#)'s Regulatory and Public Service Program listed "diseases vectored by insects" among bioterrorism scenarios considered "most likely".^[27] Because [invasive species](#) are already a problem worldwide, one [University of Nebraska–Lincoln](#) entomologist considered it likely that the source of any sudden appearance of a new agricultural pest would be difficult, if not impossible, to determine.^[28] Lockwood considers insects a more effective means of transmitting biological agents for acts of bioterrorism than the actual agents.^[29] In his opinion insect vectors are easily gathered and their eggs are easily transportable without detection.^[29] Isolating and delivering biological agents, on the other hand, is extremely challenging and hazardous.^[29]

In one of the few suspected acts of entomological bioterrorism an [eco-terror](#) group known as The Breeders claimed to have released [Mediterranean fruit flies](#) (medflies) amidst an ongoing [California](#) infestation.^[30] Lockwood asserts that there is some evidence the group played a role in the event.^[10] The pest attacks a variety of crops and the state of California responded with a large-scale [pesticide](#) spraying program.^[30] At least one source asserted that there is no doubt that an outside

hand played a role in the dense 1989 infestation.^[31] The group stated in a letter to then Los Angeles Mayor [Tom Bradley](#) that their goals were twofold.^[30] They sought to cause the medfly infestation to grow out of control which, in turn, would render the ongoing [malathion](#) spraying program financially infeasible.^[30]

Legal status

The [Biological and Toxic Weapons Convention](#) (BWC) of 1972 does not specifically mention insect vectors in its text.^[32] The language of the treaty, however, does cover vectors.^[32] Article I bans "Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict."^{[32][33]} It would appear, due to the text of the BWC, that insect vectors as an aspect of entomological warfare are covered and outlawed by the convention.^[34] The issue is less clear when warfare with uninfected insects against crops is considered.^[32]

Genetically engineered insects

US intelligence officials have suggested that insects could be [genetically engineered](#) via technologies such as [CRISPR](#) to create [GMO](#) "killer mosquitoes" or plagues that wipe out staple crops.^[35] There is research ongoing to genetically modify mosquitoes to curb the spread of diseases, such as [Zika](#), and the [West Nile virus](#) by using mosquitoes modified using CRISPR to no longer carry the [pathogen](#). However, this research also shows that it may also be possible to *implant* diseases or pathogens via genetic modification.^[36] It has been suggested by the Max Planck Institute for Evolutionary Biology that current US research into genetically modified insects for crop protection via infectious diseases which spread genetic modifications to crops *en masse* could lead to the creation of genetically modified insects for use in warfare.^{[37][38]}

See also

- [1989 California medfly attack](#)
- [War against the potato beetle](#)
- [Agroterrorism](#)
- [Entomology](#)
- [Military animal](#)
- [Brain implant § Research and applications](#)
- [Genetically modified virus](#)

- Genetically modified virus § Insect Allies program

References

1. Peterson, R.K.D. "The Role of Insects as a Biological Weapon (http://entomology.montana.edu/historybug/insects_as_bioweapons.htm) " Archived (https://web.archive.org/web/20080705113452/http://entomology.montana.edu/historybug/insects_as_bioweapons.htm) 2008-07-05 at the [Wayback Machine](#), Department of Entomology, *Montana State University*, notes based on seminar, 1990, accessed December 25, 2008.
2. Lockwood, Jeffrey A. *Six-legged Soldiers: Using Insects as Weapons of War*, Oxford University Press, USA, 2008, pp. 9–26, (ISBN 0195333055).
3. "An Introduction to Biological Weapons, Their Prohibition, and the Relationship to Biosafety (<http://www.sunshine-project.org/publications/bk/pdf/bk10en.pdf>) Archived (<https://web.archive.org/web/20130512163809/http://www.sunshine-project.org/publications/bk/pdf/bk10en.pdf>) 2013-05-12 at the [Wayback Machine](#)", *The Sunshine Project*, April 2002, accessed December 25, 2008.
4. Kirby, Reid. "Using the flea as weapon (<https://web.archive.org/web/20070611071747/http://www.wood.army.mil/chmdsd/pdfs/Jul-Dec%202005/Kirby.pdf>) ", (Web version (http://findarticles.com/p/articles/mi_m0IUN/is_2005_July/ai_n16057441/pg_1?tag=artBody;col1) via [findarticles.com](#)), *Army Chemical Review*, July 2005, accessed December 23, 2008.
5. Baumann, Peter. "Warfare gets the creepy-crawlies (<https://archive.today/20121216100350/http://www.laramieboomerang.com/articles/2008/10/18/news/doc48f977a7251e2862310310.txt>) ", *Laramie Boomerang*, October 18, 2008, accessed December 23, 2008.
6. "UW Professor Examines Biological Setting of Egyptian Plagues (<http://www.uwyo.edu/news/showrelease.asp?id=4819>) Archived (<https://web.archive.org/web/20110617053132/http://www.uwyo.edu/news/showrelease.asp?id=4819>) 2011-06-17 at the [Wayback Machine](#)", (Press release), *University of Wyoming*, December 12, 2005, accessed December 23, 2008.
7. Lockwood, Jeffrey A. "Bug Bomb (http://www.boston.com/news/globe/ideas/articles/2007/10/21/bug_bomb/) ", *Boston Globe*, October 21, 2007, accessed December 23, 2008.
8. Croddy, Eric and Wirtz, James J. *Weapons of Mass Destruction: An Encyclopedia of Worldwide Policy, Technology, and History*, (Google Books (<https://books.google.com/books?id=ZzINgS70OHAC&dq=%22Operation+Big+Itch%22&pg=PA304>)), ABC-CLIO, 2005, p. 304, (ISBN 1851094903).

9. Heather, Neil W. and Hallman, Guy J. *Pest Management and Phytosanitary Trade Barriers* ([Google Books]), CABI, 2008, pp. 17–18, (ISBN 1845933435).
10. Baker, Eric. "'Maggot bombs' and malaria (<http://www.casperstartribune.net/articles/2006/02/27/news/wyoming/bfb227bae65ea9df8725712100267bd5.txt>) ", *Casper Star-Tribune*, via the *Laramie Boomerang*, February 27, 2006, accessed December 25, 2008.
11. Endicott, Stephen, and Hagerman, Edward. *The United States and Biological Warfare: Secrets from the Early Cold War and Korea*, (Google Books (<https://books.google.com/books?id=P8HgoMBKi0YC&q=The+United+States+and+Biological+Warfare+Secrets+from+the+Early+Cold+War+and+Korea>) , relevant excerpt (<https://www.nytimes.com/books/first/e/endicott-biological.html>)), Indiana University Press, 1998, pp. 75-77, (ISBN 0253334721), links accessed December 24, 2008.
12. Wheelis, Mark, et al. *Deadly Cultures: Biological Weapons Since 1945*, (Google Books (<https://books.google.com/books?id=Usskez9NfEYC&dq=Canada+biological+weapons&pg=PA84>)), Harvard University Press, 2006, pp. 84-90, (ISBN 0674016998).
13. Lockwood, Jeffrey A. "Six-legged soldiers (<http://www.the-scientist.com/news/print/55104/>) Archived (<https://web.archive.org/web/20100522081722/http://www.the-scientist.com/news/print/55104/>) 2010-05-22 at the Wayback Machine", *The Scientist*, October 24, 2008, accessed December 23, 2008.
14. Novick, Lloyd and Marr, John S. *Public Health Issues Disaster Preparedness*, (Google Books (<https://books.google.com/books?id=AiWKXMn66YcC&dq=%22entomological+warfare&pg=PA87>)), Jones & Bartlett Publishers, 2001, p. 87, (ISBN 0763725005).
15. McCurry, Justin (2018-04-17). "Unit 731: Japan discloses details of notorious chemical warfare division" (<https://www.theguardian.com/world/2018/apr/17/japan-unit-731-imperial-army-second-world-war>) . *The Guardian*. ISSN 0261-3077 (<https://search.worldcat.org/issn/0261-3077>) . Retrieved 2024-12-13.
16. Ban, Jonathan. "Agricultural Biological Warfare: An Overview (<http://www.mipt.org/pdf/agrobiowarfareoverview.pdf>) Archived (<https://web.archive.org/web/20010920103524/http://www.mipt.org/pdf/agrobiowarfareoverview.pdf>) 2001-09-20 at the Wayback Machine", *The Arena*, June 2000, Paper #9, Chemical and Biological Arms Control Institute, via Memorial Institute for the Prevention of Terrorism, accessed December 25, 2008.
17. Regis, Ed. "Wartime Lies? (https://www.nytimes.com/books/99/06/27/reviews/990627.27reg.html?_r=2) ", *The New York Times*, June 27, 1999, accessed December 24, 2008.

18. "Reviews of The United States and Biological Warfare: secrets of the Early Cold War and Korea (<http://www.yorku.ca/sendicot/reviews.htm>) ", *York University*, compiled book review excerpts, accessed December 24, 2008.
19. Auster, Bruce B. "Unmasking an Old Lie (https://www.usnews.com/usnews/news/articles/981116/archive_005192.htm) Archived (https://web.archive.org/web/20110524213923/http://www.usnews.com/usnews/news/articles/981116/archive_005192.htm) 2011-05-24 at the Wayback Machine", *U.S. News & World Report*, November 16, 1998, accessed December 24, 2008.
20. Rose, William H. "An Evaluation of Entomological Warfare as a Potential Danger to the United States and European NATO Nations (<http://www.thesmokinggun.com/archive/mosquito1.htm>) ", U.S. Army Test and Evaluation Command, *Dugway Proving Ground*, March 1981, via *thesmokinggun.com*, accessed December 25, 2008.
21. "Bugs keep Group Humming at Kadena". *Pacific Stars and Stripes*. August 2, 1968.
22. National Academy of Sciences (U.S.) (1966). *International Activities of the National Academy of Sciences-National Research Council, 1964/1965* (<https://books.google.com/books?id=KUQrAAAYAAJ&pg=PA59>) . National Academies. pp. 59–. NAP:11015. Retrieved April 17, 2013.Ⓒ This article incorporates text from this source, which is in the public domain.
23. Moynihan (July 29, 1974). "Indian press articles on W.H.O. Biogenetic Mosquito control Project and Migratory Bird Project, Document Number: 1974NEWDE10039" (<https://web.archive.org/web/20130616050636/http://aad.archives.gov/aad/createpdf?rid=107877&dt=2474&dl=1345>) . *US Department of State EO Systematic Review, US Department of State*. US Department of State via NARA. Archived from the original (<https://aad.archives.gov/aad/createpdf?rid=107877&dt=2474&dl=1345>) on June 16, 2013. Retrieved April 14, 2013.Ⓒ This article incorporates text from this source, which is in the public domain.
24. Powell, Kendall; Jayaraman, K. S. (2002). "Mosquito Researchers Deny Plotting Secret Biowarfare Test" (<https://doi.org/10.1038%2F419867a>) . *Nature*. **419** (6910): 867. Bibcode:2002Natur.419..867P (<https://ui.adsabs.harvard.edu/abs/2002Natur.419..867P>) . doi:10.1038/419867a (<https://doi.org/10.1038%2F419867a>) . PMID 12410269 (<https://pubmed.ncbi.nlm.nih.gov/12410269>) .
25. Irwin, M.E. and G.E. Kampmeier. "Commercial products, from insects (<http://www.inhs.uiuc.edu/~gkamp/downloads/CommInsects.pdf>) ", (p. 6). In Resh, V.H. & Carde, R. eds. *Encyclopedia of Insects*, Academic Press, San Diego, via *University of Illinois* and Illinois Natural History Survey, accessed December 25, 2008.

26. Merry, Stephanie (3 December 2021). "Analysis | The insect warfare on 'The Americans' isn't all that outlandish" (<https://www.washingtonpost.com/news/arts-and-entertainment/wp/2017/03/22/the-insect-warfare-on-the-americans-isnt-all-that-outlandish/>) . *Washington Post*. Archived (<https://web.archive.org/web/20170322113328/https://www.washingtonpost.com/news/arts-and-entertainment/wp/2017/03/22/the-insect-warfare-on-the-americans-isnt-all-that-outlandish/>) from the original on 22 March 2017.
27. "Regulatory and Public Service Programs' Strategy for the Prevention Of Bioterrorism in Areas Regulated (http://drpsp.clemson.edu/Terrorism_Prevention.PDF) Archived (https://web.archive.org/web/20090117133829/http://drpsp.clemson.edu/Terrorism_Prevention.PDF) 2009-01-17 at the [Wayback Machine](#)", Regulatory and Public Service Program, *Clemson University*, 2001, accessed December 25, 2008.
28. Corley, Heather. "Agricultural Bioterror Threat Requires Vigilance (<http://ianrnews.unl.edu/static/0111121.shtml>) Archived (<https://web.archive.org/web/20120218075510/http://ianrnews.unl.edu/static/0111121.shtml>) 2012-02-18 at the [Wayback Machine](#)", (Press release), Institute of Agriculture and Natural Resource, *University of Nebraska–Lincoln*, November 12, 2001, accessed December 25, 2008.
29. Lockwood, Jeffrey A. "Insects: Tougher than anthrax (http://www.boston.com/news/globe/ideas/articles/2007/10/21/insects_tougher_than_anthrax/) ", *The Boston Globe*, October 21, 2007, accessed December 25, 2008.
30. Bonfante, Jordan. "Medfly Madness (<https://web.archive.org/web/20080724201507/http://www.time.com/time/magazine/article/0,9171,969129,00.html>) ", *Time*, January 8, 1990, accessed December 25, 2008.
31. Howard, Russell D. et al. *Homeland Security and Terrorism: Readings and Interpretations*, (Google Books (<https://books.google.com/books?id=ViC49z8oQL0C&dq=The+Breeder+medfly&pg=RA1-PA49>)), McGraw-Hill Professional, 2006, p. 49, (ISBN 0071452826).
32. Sims, Nicholas Roger Alan, ([Stockholm International Peace Research Institute](#)). *The Evolution of Biological Disarmament*, (Google Books (https://books.google.com/books?id=wGq_ToZF3YgC&dq=Biological+weapons+convention+insect+vectors&pg=PT41)), Oxford University Press, 2001, pp. 45-50, (ISBN 0198295782).

33. "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (<http://www.opbw.org/convention/documents/btwctext.pdf>) Archived (<https://web.archive.org/web/20080512033951/http://www.opbw.org/convention/documents/btwctext.pdf>) 2008-05-12 at the [Wayback Machine](#)", The Biological and Toxic Weapons Convention Website, accessed January 5, 2009.
34. Zanders, Jean Pascal. "Research Policies, BW Development & Disarmament (<http://www.bwpp.org/publications/reports/040204-eu-bw-ethics.pdf>) Archived (<https://web.archive.org/web/20081006180504/http://www.bwpp.org/publications/reports/040204-eu-bw-ethics.pdf>) 2008-10-06 at the [Wayback Machine](#)", Conference: "Ethical Implications of Scientific Research on Bioweapons and Prevention of Bioterrorism", [European Commission](#), via *BioWeapons Prevention Project*, February 4, 2004, accessed January 5, 2009.
35. Regalado, Antonio. "Top U.S. Intelligence Official Calls Gene Editing a WMD Threat" (<https://www.technologyreview.com/s/600774/top-us-intelligence-official-calls-gene-editing-a-wmd-threat/>) . MIT Technology Review. Retrieved 26 December 2016.
36. Jason Rasgon, "Genetically modified mosquitoes may be the best weapon for curbing disease transmission" (<https://theconversation.com/genetically-modified-mosquitoes-may-be-best-weapon-for-curbing-disease-transmission-100719>) , *The Conversation*, Retrieved 20th May 2019
37. Kai Kupferschmidt, "Crop-protecting insects could be turned into bioweapons, critics warn" (<https://www.science.org/content/article/crop-protecting-insects-could-be-turned-bioweapons-critics-warn>) , *Science*, Retrieved 20th May 2019
38. R. G. Reeves, S. Voeneky, D. Caetano-Anollés, F. Beck, C. Boëte, "Agricultural research, or a new bioweapon system?" (<https://www.science.org/doi/10.1126/science.aat7664>) , *Science*, Retrieved 20th May 2019

Further reading

- Bryden, John. *Deadly Allies: Canada's Secret War, 1937-1947*, (Google Books (<https://books.google.com/books?id=knzcAAAACAAJ>) Archived (<https://web.archive.org/web/20230719220655/http://books.google.com/books?id=KnZCAAAAcAAJ>) 2023-07-19 at the [Wayback Machine](#)), McClelland & Stewart, 1989, (ISBN 0771017243).
- Garrett, Benjamin C. "The Colorado Potato Beetle Goes to War (<http://www.sussex.ac.uk/Units/sp ru/hsp/documents/CWCB33-Garrett.pdf>) ", *Chemical Weapons Convention Bulletin*, Issue #33, September 1996, accessed January 3, 2009.

- Hay, Alastair. "A Magic Sword or A Big Itch: An Historical Look at the United States Biological Weapon Programme", (Citation (<https://www.ncbi.nlm.nih.gov/pubmed/10472190>)), *Medicine, Conflict and Survival*, Vol. 15 July–September 1999, pp. 215–234).
- Lockwood, Jeffrey A. "Entomological Warfare: History of the Use of Insects as Weapons of War" (Citation (<http://www.fao.org/agris/search/display.do?f=.%2F1988/v1412/US875139588.xml;US875139588>)), *Bulletin of the Entomological Society of America*, Summer 1987, v. 33(2), pp. 76–82.
- Lockwood, Jeffrey A. "The Scary Caterpillar (<https://www.nytimes.com/2009/04/19/opinion/19lockwood.html?ref=opinion>) ", *The New York Times*, April 18, 2009, accessed April 24, 2009.
- Lockwood, J. A. (2012). "Insects as Weapons of War, Terror, and Torture". *Annual Review of Entomology*. **57**: 205–227. doi:10.1146/annurev-ento-120710-100618 (<https://doi.org/10.1146/annurev-ento-120710-100618>) . PMID 21910635 (<https://pubmed.ncbi.nlm.nih.gov/21910635>) .

External links

- The Biological and Toxic Weapons Convention (<https://web.archive.org/web/20080410065841/http://www.opbw.org/>) , official site, accessed January 5, 2009.
- Bugs as bombs (https://web.archive.org/web/20081210183813/http://www.ent.orst.edu/burgett/ent300_lecture14.htm) , *Oregon State University*, Department of Entomology, accessed December 25, 2008.